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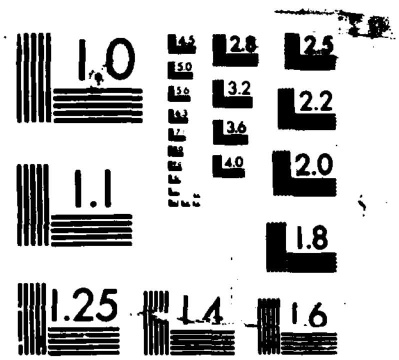

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COMMENT ON PAPER BY YAU AND CHOU TITLED "NOTCHED STRENGTH OF WOVEN FABRIC COMPOSITES WITH MOLDED-IN HOLES"

J. H. UNDERWOOD

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DECEMBER 1986

US ARMY ARMAMENT RESEARCH AND DEVELOPMENT CENTER
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A comment is offered on the Yau and Chou paper, presented at the Eighth ASTM Conference on Composite Materials: Testing and Design, which discussed the failure strength of fabric composite plates with holes. Classical mechanics is used to describe the change in failure strength with hole size.

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INTRODUCTION

The subject paper by Yau and Chou (ref 1) was presented at the Eighth ASTM Conference on Composite Materials: Testing and Design and will be published in the ASTM STP Conference Proceedings.

DISCUSSION

During the oral presentation on this study of notched strength of composites, it was noted by author Yau that the net-section strength of the specimens increased with hole size for some test conditions. The purpose of this comment is to compare this increase in net-section stress with the classic change in stress concentration factor due to hole size in a finite width plate (ref 2). Data for such a comparison are shown in Table 1 of this comment. The Yau and Chou values of failure strengh from their Tables 1 through 4 have been converted to net-section failure strengths by accounting for the hole size, and then normalized by the value for the 3.2 mm diameter hole, for ease of comparison. All the molded-in hole results are listed. The expected decrease in stress concentration factor, K, with increase in hole size is also shown in Table 1 of this comment, both as K and normalized K, taken from Reference 2 for the Yau and Chou specimen and hole dimensions.

The comparison shows that the increase in net-section strength for epoxy specimens follows the same trend as the decrease in stress concentration factor. For both tension and compression loading, the increase in net-section strength can be well described by the continuum mechanics, K approach. Of course this is not generally true, as shown by the PEEK specimen results. In this material, both tension and compression net-section strength decreases with increasing hole size. Since the PEEK composites

have a relatively tough matrix, correspondence between their failure strengths and elastic continuum mechanics is less expected than with the relatively brittle, epoxy-matrix composites.

CONCLUSION

This comparison indicates that continuum mechanics has a rightful place in the analysis of structural behavior of composites. Care must be taken in the application of continuum mechanics to "unbalanced" composite materials, those whose structural behavior is heavily biased by one component. A ductile matrix, such as the PEEK discussed here, or fibers predominantly in one direction, may make continuum approaches useless. Nevertheless, many composites, such as the woven carbon-epoxy discussed here, are close enough to a continuum to be well described by classical continuum mechanics.

REFERENCES

1. S. S. Yau and T. W. Chou, "Notched Strength of Woven Fabric Composites With Molded-In Holes," presented at the Eighth ASTM Conference on Composite Materials: Testing and Design (to be published in the Conference Proceedings).

2. S. Timoshenko, Strength of Materials, Part II: Advanced Theory and Problems, Krieger Publishing Company, Hungington, NY, 1976, pp. 306-308.

TABLE 1. COMPARISON OF FAILURE STRENGTH OF WOVEN COMPOSITES CONTAINING MOLDED-IN HOLES WITH STRESS CONCENTRATION FACTOR

Hole Diameter	Epoxy Specimens				PEEK Specimens				Stress Concentration Factor (Ref. 1)	
	Net Tension Strength		Net Compression Strength		Net Tension Strength		Net Compression Strength			
mm	σ MPa	$\sigma/\sigma_{3.2}$ -	σ MPa	$\sigma/\sigma_{3.2}$ -	σ MPa	$\sigma/\sigma_{3.2}$ -	σ MPa	$\sigma/\sigma_{3.2}$ -	K -	$K_{3.2}/K$ -
3.2	385	1.0	503	1.0	641	1.0	433	1.0	2.85	1.0
6.4	419	1.09	565	1.12	580	0.90	368	0.85	2.35	1.10
9.5	450	1.17	578	1.15	555	0.87	347	0.80	2.22	1.16

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